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An economic feasibility assessment of lagoon dredging in Funafuti, Tuvalu

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ABTRACT

Finding a sustainable source of aggregate (sand, gravel, rip-rap) is a major concern for many Pacific Island countries. In countries such as Tuvalu, expensive imports are used for large-scale construction while households rely on ad hoc mining from the foreshore and inland. Mining is believed to have negative environmental repercussions – that is, past SOPAC studies have noted the link between aggregate mining and coastal vulnerability. In an effort to find a sustainable alternative source of aggregate, the Government of Tuvalu has expressed interest in investigating the viability of dredging aggregates from Funafuti lagoon. SOPAC was requested to conduct a benefit-cost analysis of lagoon dredging. To that end, a report was produced which contains a financial and economic assessment of a hypothetical dredge. The financial assessment investigates whether a dredge would be financially self-sufficient; that is, whether revenues would exceed costs. The economic assessment compares the socioeconomic costs and benefits under the 'future with a dredge' and 'future without a dredge' scenarios. It is found that a lagoon dredge would generate profits over a twenty-five year period. Furthermore, the economic internal rate of return is 13%, indicating that a dredging project would generate net economic gains over a twenty-five year period. A sensitivity analysis was conducted to test the robustness of both the financial and economic assessments. These results can be used to inform the Government of Tuvalu on whether to continue considerations of lagoon dredging.

INTRODUCTION

At present, the Pacific Islands Applied Geoscience Commission (SOPAC) is executing a European Development Fund (EDF) project: *Reducing vulnerability in Pacific ACP states*. This project's main aim is to reduce vulnerability to natural disasters in Pacific ACP states through the development of an integrated planning and management system. This system targets three areas:

- hazard mitigation and risk assessment;
- aggregates for construction; and
- water resources and sanitation.

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The project intends to address problems such as: the unavailability of accurate and timely data; a weak human resource base; limited financial resources and infrastructure; and lack of appropriate management plans, policies and regulatory frameworks to deal with these focal areas.

Under the EDF *Reducing vulnerability* project, a number of activities have taken place to support the community of Tuvalu in understanding and tackling its erosion and flood problems. These include identifying the contribution of aggregate mining to erosion (Webb 2005) as well as confirming the existence of an adequate quantity of construction-suitable aggregates in Funafuti lagoon (Smith 1995).

The government is unsure as to whether lagoon dredging is a viable, sustainable option for meeting aggregate needs. As a result, a preliminary assessment is presented in order to enable the government to determine whether to give this issue further consideration. SOPAC has already completed economic analyses of lagoon dredging in other atoll environments, such as the Marshall Islands (McKenzie et al. 2005) and Kiribati (Greer 2007).

LAGOON DREDGING IN FUNAFUTI, TUVALU

Funafuti, Tuvalu, is currently facing a challenge in accessing much needed aggregates (sand, gravel and small rocks used in construction). Most aggregate is sourced from the beaches. However, there is only a limited amount available and removing too much may contribute to erosion (Webb 2005). Some large-scale projects import aggregate, but this is prohibitively expensive for most households. In the past, there have also been negative environmental impacts from imports when plant pests were inadvertently brought into the country (Orapa 2005).

One option which would both reduce erosion and meet Funafuti's growing need for aggregate is targeting sand resources located in Funafuti lagoon. A pilot dredging project in Funafuti lagoon was conducted in the early 1990s which produced 1 000 m^3 of aggregate (Eade 1995). The pilot project's Environmental Impact Assessment revealed that dredging did not have any negative consequences on the lagoon environment (Kaly & Jones 1994). Present-day dredging is therefore technically feasible, yet questions exist as to its sustainability, both from an environmental and economic perspective. At present, the government is undecided as to whether to further investigate lagoon dredging. Consequently, no discussions have taken place on the possible scale, form and nature of production. To help the Government of Tuvalu decide whether lagoon dredging should be examined and, if so, what issues it might consider, a preliminary economic analysis has been conducted. It is critical to recognize that this analysis is highly preliminary and that it should, at best, only form the basis for future discussions with relevant stakeholders. Any follow-up work must include new financial and economic analyses based on the collection of more detailed and accurate data.

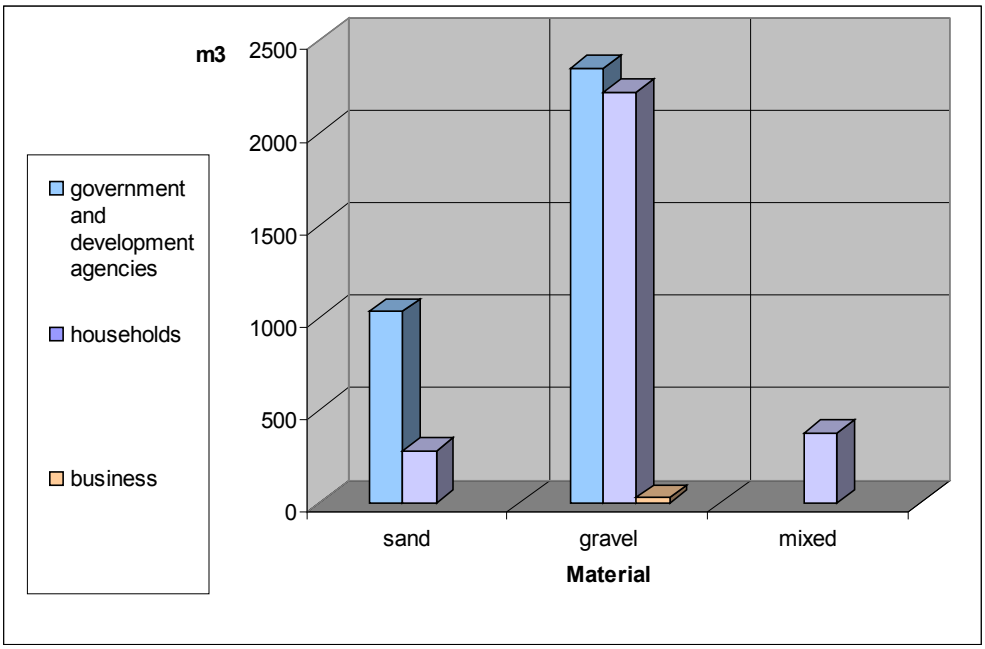
A hypothetical dredge was analysed for the financial and economic feasibility. This hypothetical project was based on similar projects which had already been analysed – notably a study of lagoon dredging in Tarawa lagoon, Kiribati (Greer 2007), and an assessment of a dredging and borrow pit filling project in Funafuti (Shimata and Brady 2003). Using these two studies as a base, costs were estimated for a dredge appropriate in scale to Funafuti's current needs. The scale chosen for the hypothetical dredge was 23 000 m^3. At this rate, the borrow pits and low-lying areas of Funafuti could be filled in 25 years.

The lagoon resource could also be used to fulfil Funafuti demand for aggregates for construction and maintenance. In particular, it was assumed that the dredge could substitute for reported local mining and substitute 75% of imports (excluding large development projects). It is expected that switching to dredged aggregates will afford gains to the community as the dredge would reduce Funafuti's dependence on expensive imports which pose a quarantine risk, as well as reduce local mining which adversely impacts the integrity of the coastline. It is not expected that the dredge will substitute for unreported and illegal local mining, since users who engage in such mining likely view their activities as costless. As a result, they would be unlikely to pay for dredged aggregate from the lagoon. If the lagoon aggregate is used for both filling the borrow pits and satisfying a portion of local demand for construction, it will take approximately 39 years to fill all the borrow pits and low-lying areas.

At present, no government policy has been outlined regarding how to fill the borrow pits and low-lying areas. If the Government of Tuvalu intends to use dredged aggregate for a borrow pit filling project – as the analysis suggests – budgetary resources would need to be allocated for the purchase of aggregate and associated project costs.

Due to limited availability of data, a household survey was conducted in order to gauge the amount of aggregate demanded per year by households (Ambroz forthcoming) This survey revealed that current construction demand for aggregate on Funafuti is low (just over 6 000 m^3 per year). It is therefore unlikely to ever be cost effective to dredge only to meet current use. Instead, feasibility is assessed on the expectation that some of the dredged aggregate would be purchased for infilling purposes.

Figure 1 Funafuti average per year aggregate demand, by material



The financial analysis revealed that a dredge would generate profits over time. There are several caveats, however. First, dredged aggregate was assumed to be sold at the current price for local sand and gravel: A$ 2 per bag. Second, financial sustainability depends on the government's commitment to buy dredged aggregate so that the entire production level of 23 000 m^3 is sold. The aggregate can be either stockpiled or used immediately for a borrow pit filling project. The minimum expenditure that the government would need to commit would be A$ 330 000 per year. If the government commits to spending this amount, the dredge could just break even (no profits but at least costs covered). To ensure that the dredge operates at greater capacity and makes profits, the government would need to spend as much as A$ 1.3 million per year. If these two conditions are met (sale at current Kaupule price and purchase by government), a dredging project would most likely be financially viable.

Table 1 Net economic gains of a future with scenario

Future with scenario	Economic gains*	EIRR	Comment
Option 1: Borrow pit filling + fulfilling construction demand	$ 1 084 955	13 %	Largest measured gains come from replacing expensive imported aggregate with cheaper dredged aggregate. This may overvalue imports' importance, however, compared to the

			environmental benefits of filling the borrow pits.
Option 2: Borrow pit filling only	- $ 508 090	-	Artificially low gains since most of the environmental benefits could not be adequately quantified.

* Over twenty-five years, discounted at a rate of 10%.

The economic analysis estimated a rate of return of 13% for a dredging project which contributed to borrow pit filling and addressed local construction demand (Table 1). A rate of return larger than 10% implies that a project is economically beneficial. This return is highly dependent upon the ability of lagoon sourced aggregates to displace aggregate imports. Additionally, the estimated rate of return is an approximate figure. It is most likely an underestimate since many of the environmental benefits could only be imperfectly measured, if they could be quantified at all. Environmental benefits which were quantified were savings on shoreline reclamation expenditures (from filling the borrow pits) and savings on quarantine risk management (from alleviating some of Fongafale reliance on imports). The dredge also displaced reported local mining, which amounted to further savings since the cost per cubic meter of local mining exceeds the cost per cubic meter of dredging.

DISCUSSION

It is suggested that further investigations of dredging be made. The analyses in this report indicated potential positive returns for a dredging project, both financial and economic. However, these results are preliminary and come with caveats – most particularly being the government commitment which is required. The cost estimates on which the results are based are also approximate figures. Any future investigation of lagoon dredging would require more accurate cost data. There is also the possibility of seeking development funding for the initial investment in dredge capital and equipment.

There are several questions which the report raises, as they would affect the financial and economic assessments: What should be the final scale of dredging? What would the future price of lagoon-dredged aggregate be? How quickly should the borrow pits and low-lying areas be addressed? That is, what is the desired rate of borrow pit filling? There are also policy implications. For example, it is assumed throughout the analyses that government agencies will use dredged aggregate for their construction and maintenance works as well as for any borrow pit filling project. Every year, a substantial budgetary allocation would need to be made in order to ensure that revenues at least covered costs. Furthermore, it is assumed that the Kaupule would discourage mining from the designated mining area on the ocean-side foreshore, encouraging households and businesses to instead use dredged aggregate from the lagoon. These and other issues would need to be discussed by Tuvaluan stakeholders as they would affect the nature and viability of any dredging project.

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